



GB04/4519



INVESTOR IN PEOPLE

The Patent Office
 Concept House
 Cardiff Road
 Newport
 South Wales
 NP10 8QQ

REC'D 29 NOV 2004

WIPQ

POT

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN
 COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

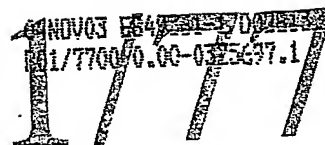
Dated 3 November 2004

BEST AVAILABLE COPY

BEST AVAILABLE COPY

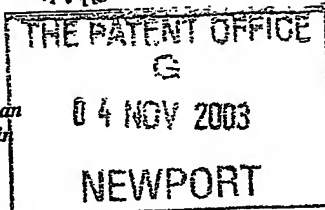
Patents Form 1/77

Patents Act 1977
(Rule 16)



Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your Reference P51382C GB

2. Patent Application Number
(The Patent Office will fill in this part) 0325697.1

3. Fill name, address and postcode of the or of each applicant (underline all surnames)

Tyco Electronics Raychem NV
 Diestsesteenweg 692
 B-3010 Kessel-Lo
 Belgium

 Patents ADP number (if you know it) 7954401001
 If the applicant is a corporate body, give the country/state of its incorporation Belgium

4. Title of the invention OPTICAL FIBRE CONNECTOR

5. Name of you agent (if you have one) Fry Heath & Spence LLP

The Gables
 Massetts Road
 Horley
 Surrey RH6 7DQ

 Patents ADP number (if you know it) 05880273001 8459554001

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

	Country	Priority application number (if you know it)	Date of filing (day / month / year)

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

	Number of earlier UK application	Date of filing (day / month / year)

8. Is a Patents Form 7/77 (statement of inventorship and of right to grant of a patent) required in support of this request? Yes

Answer 'Yes' if:

 - a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
 - c) any named applicant is a corporate body.

Otherwise answer NO See note (d)

Patents Form 1/77

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form

Description 14

Claims(s) 6

Abstract

Drawing(s) 9 + 9 *JK*

10. If you are also filing any of the following, state how many against each item.

Priority documents Nil

Translations of priority documents Nil

Statement of inventorship and right to grant of a patent (Patents Form 7/77) Nil

Request for preliminary examination and search (Patents Form 9/77) One

Request for substantive examination (Patents Form 10/77) Nil

Any other documents (please specify) Nil

11. I/We request grant of a patent on the basis of this application.

Signature(s)

Anthony Clayton-Hathway

Date 3/11/03

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom Tony Clayton-Hathway

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

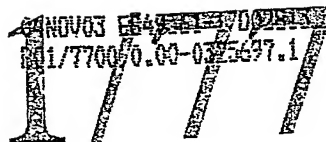
Notes

- a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 00449 200505.
b) Write your answers in capital letters using block letters for all the form.

There is no charge for the use of this form. It is available to all persons who are interested in the patent system. It is also available to persons who are interested in the patent system.

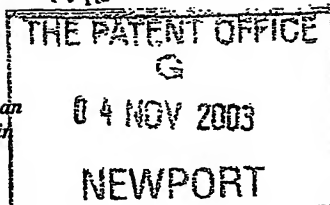
Patents Form 1/77

Patents Act 1977
(Rule 16)



Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your Reference

P51382C GB

2. Patent Application Number
(The Patent Office will fill in this part)

0325697.1

3. Fill name, address and postcode of the or of each applicant (underline all surnames)

Tyco Electronics Raychem NV
Diestsesteenweg 692
B-3010 Kessel-Lo
Belgium

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

7954407105
Belgium

4. Title of the invention

OPTICAL FIBRE CONNECTOR

5. Name of you agent (if you have one)

Fry Heath & Spence LLP

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

The Gables
Massetts Road
Horley
Surrey RH6 7DQ

Patents ADP number (if you know it)

05880273001

8459554001

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country

Priority application number
(if you know it)

Date of filing
(day / month / year)

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application

Date of filing
(day / month / year)

8. Is a Patents Form 7/77 (statement of inventorship and of right to grant of a patent) required in support of this request?

Yes

Answer 'Yes' if:

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
 - c) any named applicant is a corporate body.
- Otherwise answer NO See note (d)

Patents Form 1/77

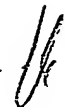
9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form

Description 14

Claims(s) 6

Abstract

Drawing(s) 9 + 9 

10. If you are also filing any of the following, state how many against each item.

Priority documents Nil

Translations of priority documents Nil

Statement of inventorship and right to grant of a patent (Patents Form 7/77) Nil

Request for preliminary examination and search (Patents Form 9/77) One

Request for substantive examination (Patents Form 10/77) Nil

Any other documents (please specify) Nil

11. I/We request grant of a patent on the basis of this application.

Signature(s)



Date 3/11/03

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom Tony Clayton-Hathway

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 02 459 500305.

b) Write your answers in capital letters using black ink or you may use a computer.

c) Do not write on the back of this form or on any other sheet of paper which is part of the application. If you need more space, you may use a separate sheet of paper, but you must attach it to the back of this form.

Optical Fibre Connector

The present invention relates to optical fibre connectors for forming mechanical splices between optical fibres.

There is a wide variety of designs of optical fibre connector for forming mechanical splices (i.e. splices in which the fibres are spliced together by mechanical means). An example of one type of mechanical splice connector is disclosed in US Patent No. 4,946,249. The connectors disclosed in that document each comprise a pair of housing halves which, when assembled together provide a housing having a bore extending therethrough to accommodate the fibres being spliced. The fibres generally have coatings which need to be stripped away from the end sections of the fibres that are butted together to form the splice. The bore in the connector housing is wider at the ends of the housing to accommodate the coated sections of the fibres, and narrower in the middle of the housing to accommodate the bare stripped fibres. Because there is more than one typical thickness of an optical fibre coating, some of the connector housings have differing bore diameters at opposite ends of the housing, so that dissimilar sizes of fibre can be spliced together. There is also a respective connector housing for splicing together each size of optical fibre. Consequently a range of different connector housings is required.

US Patent No. 5,963,699 discloses optical fibre mechanical splice connectors comprising a base and a lid between which spliced optical fibres are clamped, by means of an external spring clamp that holds the base and the lid together. The lid is formed from three separate sections, i.e. a single middle section for clamping both stripped bare portions of the spliced fibres, and two end sections for clamping each of the two coated fibre portions. The spring clamp is divided into three section corresponding to the three sections of the lid, so that the clamping force can be adjusted for each lid section independently of the other sections.

The present invention provides optical fibre connectors that have major advantages over the known connector systems described above, including:

(i) "half-installability", i.e. the ability to install a first optical fibre (or a first set of optical fibres) in a mechanical splice connector, and to install a second optical fibre (or a second set of fibres) to be spliced with the first fibre(s) at a later time;

(ii) the ability to close a "half-installed" mechanical splice connector such that the interior of the connector and the installed optical fibre(s) are protected, until the second optical fibre(s) is/are spliced;

(iii) the ability to clamp the first optical fibre(s) against movement in the x, y, or z directions, and also against rotation, even while the second optical fibre(s) is/are spliced to the first fibre(s) - which enables the orientation of an angled cleaved end face of the (or each) first fibre to be fixed for subsequent splicing with a second fibre;

(iv) the ability of a single mechanical splice connector to accommodate different diameters of optical fibre, for example both 250 μm diameter coated fibre and 900 μm diameter coated fibre; and

(v) the versatility of a mechanical splice connector either not to include a means of precisely aligning the spliced optical fibres (where the numerical aperture of the fibres is such that no precise alignment is required), or to include any one of a variety of alignment means, to suit particular requirements.

Other advantages of the present invention will be apparent from the rest of this specification.

Accordingly, a first aspect of the present invention provides an optical fibre connector for forming a mechanical splice between first and second bare optical fibres. The connector comprises a connector body having a first end face and a second end face. The first end face is configured to receive a first optical fibre and the second end face is configured to receive a second optical fibre. The connector body is configured to clamp the first and second optical fibres against movement in the x, y, or z directions, and also against rotation, even while the second optical fibre is being spliced to the first optical fibre. The connector body is configured to protect the interior of the connector and the installed optical fibre(s) until the second optical fibre is spliced to the first optical fibre.

with respect to the connector body to remain substantially undisturbed by subsequent clamping or unclamping of the second fibre.

By "bare optical fibres stripped of coatings" is generally meant that end portions of the fibres to be spliced are stripped of coatings, or merely that the fibres (or at least their end portions) substantially lack coatings. The stripped coatings generally comprise primary coatings and/or buffer coatings.

As indicated above, the first aspect of the present invention provides a mechanical splice connector that enables a first optical fibre to be fixed in the connector, and a second optical fibre to be spliced with the first fibre at a subsequent time, without the first fibre being disturbed. This may be required, for example, so that the major parts of an optical fibre network may be deployed, and subscribers subsequently connected to the network as and when required. One example of why it may be important not to disturb the first fibre when the second fibre is spliced with it, is that the end face of the first fibre may have been cleaved at an angle with respect to the perpendicular (from its longitudinal axis) in order to prevent or at least minimize undesirable reflections back along the fibre from the end face (which may disrupt the transmission of data in the network). A great advantage of the present invention is that it can facilitate the mechanical splicing of a first fibre with a second fibre by maintaining the rotational orientation of an angled end face of the first fibre in the mechanical splice connector, and avoiding the need to disturb such orientation when the second fibre is introduced.

This first aspect of the invention enables the clamping of the first fibre to remain substantially undisturbed by subsequent clamping or unclamping of the second fibre because the main clamping sections (which are dimensioned to clamp directly onto both bare optical fibres) comprise at least two sections arranged such that the first fibre may be clamped by a first of the sections independently of the second fibre. The connectors disclosed in US Patent No. 5,963,699 do not have this advantage because the middle section of the lid of those connectors comprises only a single section dimensioned to clamp both of

the bare fibres. Consequently, in order to clamp or unclamp a second fibre subsequently to the clamping of a first fibre, it would be necessary to unclamp the first fibre from the middle section of the lid of such a connector. Now, although the connectors disclosed in US 5,963,699 also include separate end sections that independently clamp the coated portions of the fibres (and which are not dimensioned to clamp directly onto the bare fibre stripped of coatings), the problem of the unclamping of the first fibre is still not solved, because it is a fact that an optical fibre clamped only by its outer coating (and not clamped directly onto the central bare fibre itself) is generally able to rotate about its axis. Consequently, the connectors disclosed in US 5,963,699 are not generally able to preserve the rotational orientation of a first installed fibre when a second fibre is added to, or removed from, the connector.

As described below, the connectors according to the present invention may (and preferably do) include additional independent end clamping sections arranged to clamp the coated sections of the fibres. The two or more main clamping sections arranged to clamp the bare fibres categorically are not equivalent to such additional clamping sections of the present invention or of the prior art.

As indicated above, in addition to the two or more main clamping sections configured to clamp directly onto the bare fibre of the first and second stripped optical fibres, the connector body preferably includes at least one, and preferably at least two, additional clamping sections dimensioned/configured and arranged to clamp onto coated portions of the optical fibres, i.e. portions of the fibres from which the coatings have not been stripped.

Second aspect of the invention provides an optical fibre connector for

connecting two optical fibres, the connector comprising a body having

two main clamping sections arranged to clamp directly onto the bare

fibres of the two optical fibres, and at least one additional clamping

section arranged to clamp onto coated portions of the optical fibres.

clamping of the first fibre against rotational and axial movement with respect to the connector body to remain substantially undisturbed by subsequent clamping or unclamping of the second fibre.

Preferably at least two of the clamping sections of the second aspect of the invention are the main clamping sections of the first aspect of the invention. At least one, but preferably at least two, of the clamping sections of the second aspect are the preferred additional clamping sections of the first aspect.

In particularly preferred embodiments of the invention, the connector comprises at least five clamping sections.

The connector may include at least three main clamping sections configured to clamp directly onto bare optical fibre. A first of the main clamping sections may be arranged to clamp onto the first fibre only, a second of the main clamping sections may be arranged to clamp onto the second fibre only, and a third of the main clamping sections may be arranged to clamp onto both of the first and second fibres.

The connector body of the connector according to all aspects of the invention preferably includes at least one bore arranged to accommodate the optical fibres. Preferably, the main clamping sections and the bore of the connector body are configured to clamp the bare fibre of the first and second optical fibres in the bore. The (or each) bore preferably has a first region, and a second region of greater diameter than the first region at each end of the first region. More preferably, the bore has a third region of greater diameter than the second region at each end of the second region. Preferably at least the second and third regions of the bore are substantially circular in cross-section.

In preferred embodiments of the invention, the connector may include alignment means for aligning the first and second optical fibres with each other. Preferably the optical fibres are sufficiently aligned by the alignment means to form a splice that minimizes optical losses such that any losses are of an

acceptable level. A preferred alignment means is a bore of the connector body, preferably a bore as referred to in the preceding paragraph. The bore preferably is dimensioned such that the stripped bare portions of the first and second optical fibres form a tight fit within the bore. The bore may comprise a groove of the connector body, for example a V-groove or a U-groove, and/or it may comprise a substantially circular cross-section bore. Additionally, or alternatively, the alignment means may comprise an alignment member in which the first and second optical fibres may be received and aligned. The alignment member may include an alignment bore for receiving and aligning the optical fibres. The alignment member may, for example, comprise a tube (or the like), for example a capillary tube. The tube may be formed from glass, for example. Alternatively, the alignment member may comprise at least one plate, preferably a pair of plates, each of which has an aperture for receiving a respective one of the first and second fibres. One or both plates may include a lens (e.g. a micro-lens) to assist in coupling light between the fibres. The plates may be the same as, or similar to, the Figure 13 embodiment of co-pending UK patent application number 0309908.2 filed on 30 April 2003.

A third aspect of the invention provides an optical fibre connector for forming a mechanical splice between first and second optical fibres, the connector comprising a connector body including a bore for accommodating the fibres, the bore having a first region, a second region of greater diameter than the first region at each end of the first region, and a third region of greater diameter than the second region at each end of the second region opposite to that adjacent to the first region, wherein at least the second and/or third regions of the bore are substantially circular in cross-section.

As indicated above, the present invention is described in the context of a mechanical splice between two optical fibres. However, it will be appreciated that the invention is not limited to this application and may be used in a variety of other contexts. For example, the invention may be used in a connector for a single optical fibre, or in a connector for a bundle of optical fibres. The invention may also be used in a connector for a single optical fibre, or in a connector for a bundle of optical fibres. The invention may also be used in a connector for a single optical fibre, or in a connector for a bundle of optical fibres.

The central fibre itself generally has a standard diameter irrespective of whether it is primary coated fibre or buffer coated fibre. A standard diameter for the bare fibre itself is 125 μm . Because optical fibres come in more than one size, it would be desirable to have a mechanical splice connector that could accommodate each size of fibre in one and the same device. This would avoid the need for a proliferation of different connectors for accommodating the different fibre sizes and the combinations of differently sized fibres to be spliced, as exemplified by US Patent No. 4, 946,249. The third aspect of the present invention has the advantage of providing such a connector.

Preferably the first region of the bore of the connector is dimensioned to accommodate bare optical fibre stripped of its coatings (e.g. the bare fibre having a diameter of approximately 125 μm), and each second region preferably is dimensioned to accommodate primary coated optical fibre (e.g. the primary coated fibre having a diameter of approximately 250 μm). Preferably each third region is dimensioned to accommodate buffer coated optical fibre (e.g. the buffer coated fibre having a diameter of approximately 900 μm). Consequently, one and the same connector device may accommodate bare fibre, primary coated fibre, and/or buffer coated fibre. Preferably the second and third regions of the bore are dimensioned to accommodate coated optical fibres of different respective sizes. Consequently, by means of the second and third regions of the bore, the connector according to the invention fulfils the need for an optical fibre connector that can accommodate different sizes of optical fibre (due to the fibres having different thicknesses of coatings on the bare fibre) in one and the same connector device.

In preferred embodiments of the invention, the connector body is divided into at least two parts along at least part of a length thereof, arranged such that the optical fibres may be clamped between the parts.

Preferably the connector further comprises a resilient clamp member arranged to retain the optical fibres in a clamped condition in the connector body. Advantageously, the resilient clamp member may be arranged to be

retained on the exterior of the connector body. The connector body may be arranged to retain the parts of the connector body together such that the optical fibres are clamped between the parts of the connector body.

In some embodiments of the invention, the connector may include a plurality of ferrules or other fixing members, each of which is arranged to be fixed (e.g. crimped) to a respective optical fibre such that the ferrule or other fixing member is secured in the connector body when the fibres are spliced. Such ferrules or other fixing members may assist in retaining a desired rotational orientation of its respective fibre in the connector.

The connector according to the invention may advantageously be arranged to form mechanical splices between a plurality of first and second optical fibres (e.g. multiple fibre splices). The connector body may therefore comprise a plurality of bores arranged to accommodate the plurality of first and second optical fibres.

Some preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 illustrates the components of a preferred optical fibre connector according to the invention;

Figure 2 illustrates the connector of Figure 1 in an assembled state without optical fibres installed in the connector;

Figure 3 illustrates the connector of Figures 1 and 2 in an assembled state with optical fibres installed and secured in the connector.

Figure 6 illustrates a resilient clamp member of the connector of Figures 1 to 5;

Figure 7 is a schematic diagram illustrating a method of opening the connector of Figures 1 to 6, enabling the insertion or removal of optical fibres into or from the connector;

Figure 8 illustrates a second preferred embodiment of an optical fibre connector according to the invention; and

Figure 9 is a schematic illustration showing three embodiments of alignment means of connectors according to the invention.

Figure 1 illustrates the components of a preferred optical fibre connector according to the invention. The connector 1 comprises a connector body comprising two parts 3 and 5 which divide the connector body in two along the length of the connector body. The two parts 3 and 5 may be regarded as half-shells of the connector body. The first part 3 will be designated as a base part 3, and the second part 5 will be designated as a lid part 5. The base part 3 is shown in detail in Figure 4, and the lid part 5 is shown in detail in Figure 5. Each of the parts 3 and 5 includes a longitudinal channel which, when the parts are brought together to close the connector body define a longitudinal bore 7 extending through the connector body. The bore 7 is for accommodating optical fibres 9 (refer to Figures 3 and 8) spliced in the connector in use.

The bore 7 comprises a longitudinally central first region 11, second regions 13 at each end of the first region 11, and third regions 15 at each end of the second region 13 (opposite to the ends adjacent to the first region 11). Each second region 13 has a greater diameter than the first region 11, and each third region 15 has a greater diameter than its adjacent second region 13. As described earlier in the specification, the first region 11 of the bore 7 is dimensioned to accommodate bare optical fibre stripped of coatings in a tight clamping fit when the lid part 5 and the base part 3 of the connector body are

clamped tightly together. The bare optical fibre preferably has an external diameter of approximately $125\mu\text{m}$.

As shown in Figure 4, one of the parts of the connector body, preferably the base part 3, includes a semicircular cross-section channel as its portion of the first region 11 of the bore. The other part of the connector body, preferably the lid part 5 as shown in Figure 5 preferably is substantially flat in its first region, other than small recesses 17 which help to guide and retain the fibres in position. The fact that the first region of the bore is not circular in cross-section but includes a flat section helps to clamp the bare fibre tightly in the first region. The second and third regions, however, preferably are substantially circular in cross-section, as shown in Figures 4 and 5.

One or both of the second and third regions may include one or more retaining members arranged to cut into the respective coating of the optical fibre to provide axial pull resistance, especially in order to counter creep which might otherwise occur over time. Figures 1 and 4 show retaining members 19 in the third regions 15 of the bore 7 of the base part 3.

As shown in Figures 1 and 2, the connector may include plugs 21 arranged to close, and preferably to seal, the ends of the bore 7 prior to, and during, installation of the optical fibre splice. The plugs 21 preferably prevent dust or other dirt ingress into the connector, and preferably also water ingress into the connector, which could have a detrimental effect on the integrity of the splice. The plugs are removable from the bore to enable the optical fibres to be inserted.

clamp directly onto the coated portions of the optical fibres in the second or third regions of the bore 7.

Figure 5 illustrates how the clamping sections 23 and 25 are divided from each other along the length of the connector body. There is a continuous strip 27 of the connector body extending generally along one edge of the lid part 5, and each clamping section extends from the strip 27. Other than by contact via the strip 27, each clamping section is separated from each adjacent clamping section by a gap, thereby enabling the clamping sections to move, and therefore clamp, independently of each other.

As shown most clearly in Figures 1 and 6, the connector also includes a resilient clamp member 29 in the form of a generally U cross-section resilient metal member that is configured to be retained on the exterior of the connector body. The resilient clamp member 29 is arranged to retain the lid part 5 and the base part 3 together such that they are tightly clamped around the spliced optical fibres. The two generally parallel arms of the resilient clamp member are divided into clamping sections 31, which form part of the respective clamping sections 23 and 25 of the connector body. The clamping sections 31 of the resilient clamp member enable the clamping sections 23 and 25 of the connector to clamp the fibres independently of each other. A longitudinally central clamping section of the resilient clamp member 29 includes an aperture 33 arranged to receive a protrusion 35 on the connector body to retain the clamp member in place on the connector body.

Because the connector body and the resilient clamp member include three separate main clamping sections arranged to coincide with the first region 11 of the bore 7, the stripped bare portions of two optical fibres spliced in the connector may be clamped independently of each other. Specifically, a first main clamping section 23a clamps only a first bare optical fibre, a second main clamping section 23b which clamps both of the first and second bare optical fibres. Consequently, a tremendous advantage of the invention (as described earlier) is that a first optical fibre may be installed in the connector body in

preparation for splicing with a second optical fibre to be installed in the connector body at a later time. The end face of the first optical fibre preferably is cleaved at a non-perpendicular angle with respect to the longitudinal axis of the fibre, in order to minimise back reflections. As a way of facilitating the splicing of the fibre to a second fibre (also having a non-perpendicular end face) it is preferably to determine and to retain the orientation of the end face of the first fibre in the connector body. The fact that the second fibre can be introduced into the connector body and spliced with the first fibre without requiring the unclamping of the first main clamping section 23a from the first fibre means that the orientation of the first fibre is retained.

The connector disclosed as US Patent No. 5,963,699 does not have the above advantage because the bare fibre sections of both fibres are clamped by one and the same central clamping section of that connector. The fact that there are separate clamping sections which separately clamp the coated portions of the fibres does not assist in retaining the fibre orientation, because the clamping to the coating (rather than the bare fibre) generally does not fix the orientation of a fibre against rotation.

Figure 7 is a schematic cross-sectional diagram of the assembled connector showing how the lid and base parts 3 and 5 may be separated slightly to facilitate the insertion of the optical fibres to be spliced. The lid and base parts 3 and 5 together provide a recess 35 on the open side of the resilient clamp member 29. The recess 35 has inclined side walls 36. When a specially provided wedge member 37 is inserted into the recess 35, inclined side walls 38 of the wedge member 37 co-operate with the side walls 32 of the recess to force the lid and base parts apart to be a predetermined amount. This facilitates the axial

are arranged to receive ferrules 39 (or other fixing members) crimped (or otherwise fixed) to respective optical fibres 9. The ferrules 39 preferably include protrusions on their exterior, which cut into the connector body in the regions 13 so as to fix the ferrules, and consequently their respective optical fibres, in a specific rotational orientation. The ferrules 39 preferably also axially retain their respective fibres within the connector, to provide resistance to axial pull and/or axial push of the fibres with respect to the connector body.

The lid and base parts of the connector body (of all embodiments of the invention) preferably are formed from polymer material, e.g. PPS. The resilient clamp member may be formed from the polymer or metal, but metal is generally preferred. Preferred metals include inox steel and beryllium copper. The ferrules preferably are formed from metal, and the plugs preferably are formed from polymer material.

Figure 9 is a schematic illustration showing three embodiments of alignment means of connectors according to the invention. In Figure 9(a), the alignment means is a bore of the connector body, and a longitudinally central main clamping section of the connector body (labelled "Clamp 2") clamps directly onto both of the spliced bare optical fibres, thereby aligning the two fibres with each other. Two other main clamping sections, (labelled "Clamp 1" and "Clamp 3") on each side of the Clamp 2, clamp onto only their respective individual fibres, enabling independent clamping of these fibres. In each of Figures 9(b) and 9(c), there are only two main clamping sections, labelled Clamp 1 and Clamp 3, each of which clamps directly onto a respective one of the bare optical fibres, enabling the independent clamping of the fibres. In addition, in each of these embodiments there is an alignment member located between the two main clamping sections, arranged to align the two fibres with each other. In Figure 9(b), the alignment member is a tube, in particular a glass capillary tube. In Figure 9(c), the alignment member comprises a pair of plates, each of which has an aperture for receiving a respective optical fibre, and a lens (a "micro-lens") arranged to assist in the efficient coupling of light between the fibres. As mentioned earlier in this specification, the plates may be the same as, or similar

to, the Figure 13 embodiment of co-pending UK patent application number 0309908.2 filed on 30 April 2003.

Claims

1. An optical fibre connector for forming a mechanical splice between first and second bare optical fibres stripped of coatings, the connector comprising a connector body that comprises at least two main clamping sections dimensioned to clamp directly onto the bare fibre of the first and second optical fibres, the main clamping sections arranged such that the first optical fibre may be clamped by a first of the main clamping sections independently of the second optical fibre, enabling the clamping of the first fibre against rotational and axial movement with respect to the connector body to remain substantially undisturbed by subsequent clamping or unclamping of the second fibre.
2. A connector according to claim 1, in which the connector body includes a bore arranged to accommodate the optical fibres.
3. A connector according to claim 2, in which the main clamping sections and the bore of the connector body are configured to clamp the bare fibre of the first and second optical fibres in the bore.
4. A connector according to any preceding claim, further comprising at least one additional clamping section dimensioned to clamp onto a coated portion of one of the optical fibres.
5. A connector according to claim 4, comprising at least two said additional clamping sections dimensioned to clamp onto coated portions of the optical fibres.
6. An optical fibre connector for forming a mechanical splice between first and second optical fibres, the connector comprising a connector body that comprises at least four clamping sections configured to clamp the first and second optical fibres, the clamping sections arranged such that the first optical fibre may be clamped by at least one of the clamping sections independently of

the second optical fibre, enabling the clamping of the first fibre against rotational and axial movement with respect to the connector body to remain substantially undisturbed by subsequent clamping or unclamping of the second fibre.

7. A connector according to claim 6, in which at least two of the clamping sections are main clamping sections configured to clamp directly onto bare fibre stripped of coatings, of the first and second optical fibres.
8. A connector according to claim 6 or claim 7, in which at least one of the clamping sections is an additional clamping section configured and arranged to clamp onto a coated portion of one of the optical fibres.
9. A connector according to any one of claims 6 to 8, in which at least two of the clamping sections are additional clamping sections configured and arranged to clamp onto coated portions of the optical fibres.
10. A connector according to any one of claims 6 to 9, comprising at least five clamping sections.
11. A connector according to any one of claims 1 to 5, or according to claim 7 or any claim dependent thereon, comprising at least three main clamping sections.
12. A connector according to claim 11, in which a first of the main clamping sections is arranged to clamp onto the first fibre only, a second of the main clamping sections is arranged to clamp onto the second fibre only, and a third of the main clamping sections is arranged to clamp onto both of the first and second fibres.

14. A connector according to claim 2 or any claim dependent thereon, or according to claim 13, in which the bore has a first region, and a second region of greater diameter than the first region at each end of the first region.

15. A connector according to claim 14, in which the bore has a third region of greater diameter than the second region at each end of the second region.

16. An optical fibre connector for forming a mechanical splice between first and second optical fibres, the connector comprising a connector body including a bore for accommodating the fibres, the bore having a first region, a second region of greater diameter than the first region at each end of the first region, and a third region of greater diameter than the second region at each end of the second region opposite to that adjacent to the first region, wherein at least the second and/or third regions of the bore are substantially circular in cross-section.

17. A connector according to any one of claims 14 to 16, in which the first region of the bore is dimensioned to accommodate bare optical fibres stripped of coatings in a tight clamping fit.

18. A connector according to claim 17, in which the bare optical fibre has an external diameter of approximately 125 μm .

19. A connector according to any one of claims 14 to 18, in which the second regions of the bore are dimensioned to accommodate primary coatings of the optical fibres in a tight clamping fit.

20. A connector according to claim 17, in which the primary coated optical fibre has an external diameter of approximately 250 μm .

21. A connector according to any one of claims 15 to 20, in which the third regions of the bore are dimensioned to accommodate buffer coatings of the optical fibres in a tight clamping fit.

22. A connector according to claim 21, in which the buffer coated optical fibre has an external diameter of approximately 900 μm .

23. A connector according to claim 15 or any claim dependent thereon, or according to claim 16 or any claim dependent thereon, in which the second and third regions of the bore are dimensioned to accommodate coated optical fibres of different respective sizes.

24. A connector according to any preceding claim, in which the connector body is divided into at least two parts along at least part of a length thereof, arranged such that the optical fibres may be clamped between the parts.

25. A connector according to any preceding claim, further comprising a resilient clamp member arranged to retain the optical fibres in a clamped condition in the connector body.

26. A connector according to claim 25, in which the resilient clamp member is arranged to be retained on the exterior of the connector body.

27. A connector according to claim 26 when dependent upon claims 24 and 25, in which the resilient clamp member is arranged to retain the parts of the connector body together such that the optical fibres are clamped between the parts.

28. A connector according to any preceding claim, further comprising a plurality of fixing members, each of which is arranged to be fixed, e.g. crimped, to a respective optical fibre such that the fixing member is secured in the connector body.

30. A connector according to claim 28 or claim 29, wherein a respective member enables the axial retention of its respective member.

31. A connector according to claim 1 or claim 11 or claim 12 or claim 13, further comprising at least one bore at one end of the bore when an optical fibre is not installed.

32. A connector according to any preceding claim, wherein the connector comprises mechanical splices between a plurality of first and second optical fibres.

33. A connector according to claim 32, in which the connector comprises a plurality of bores arranged to accommodate the first and second optical fibres.

34. A connector according to any preceding claim, wherein the connector comprises means for aligning the first and second optical fibres with each other.

35. A connector according to claim 34 when the connector comprises claims 2, 13, or 16, or any claim dependent therefrom, wherein the means comprises a said bore of the connector body.

36. A connector according to claim 34, in which the connector comprises an alignment member in which the first and second optical fibres are received and aligned.

37. A connector according to claim 36, in which the connector comprises a tube.

38. A connector according to claim 36, in which the connector comprises at least one plate, preferably a pair of plates, each having an aperture therein for a respective one of the first and second optical fibres.

39. A connector according to claim 38, in which each plate includes a lens to assist in coupling light between the first and second optical fibres.

...

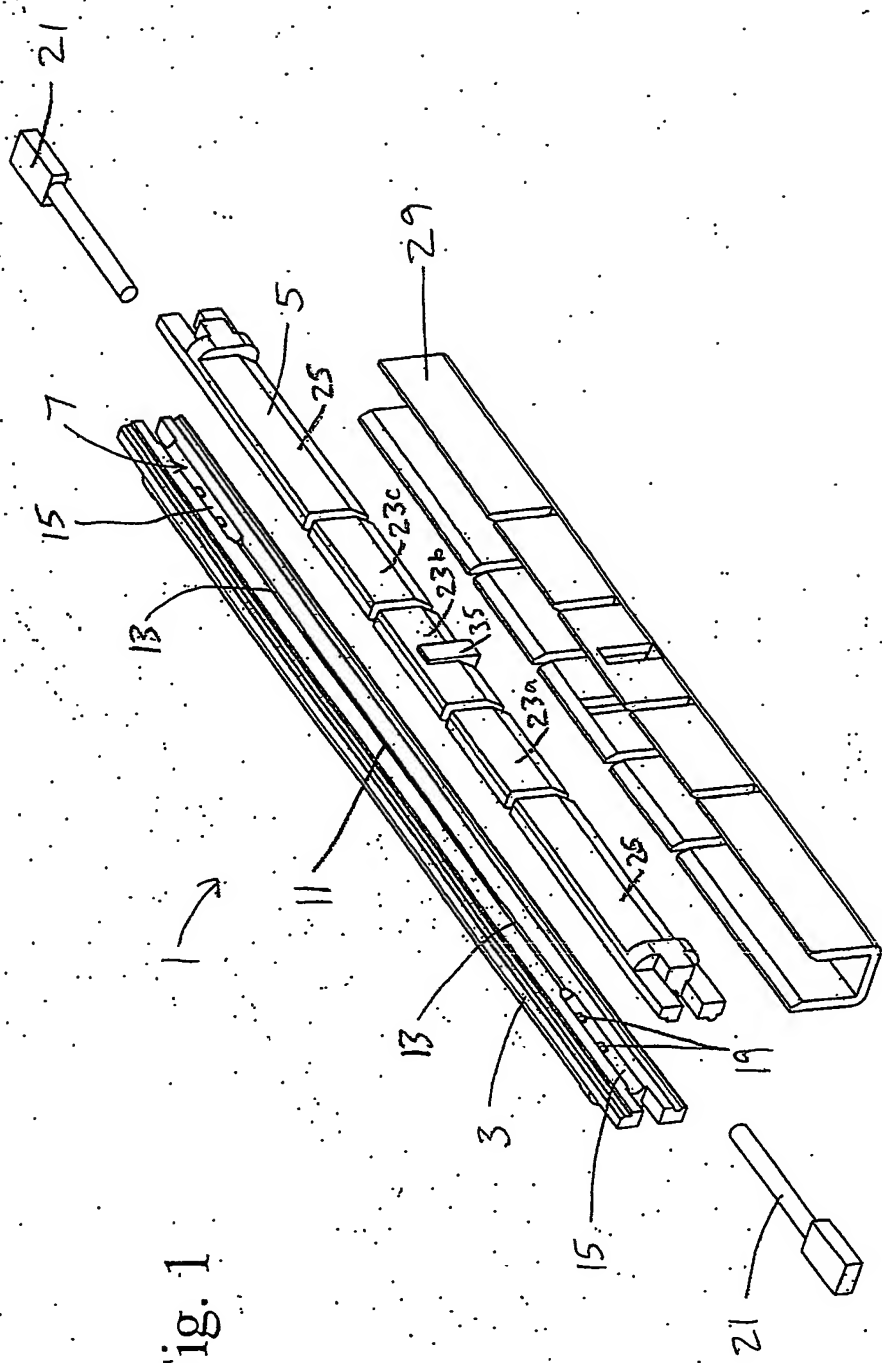


Fig. 1

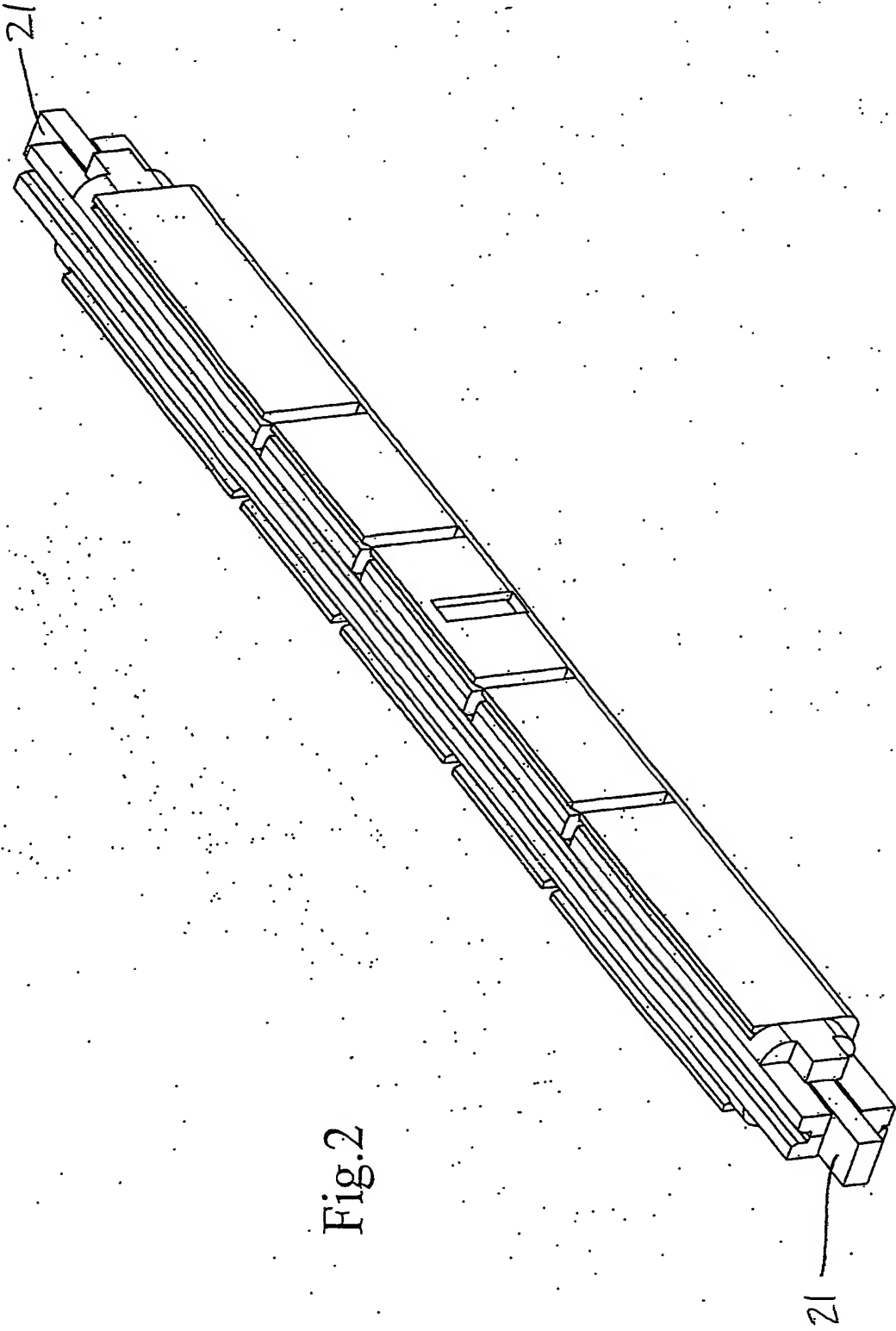


Fig.2

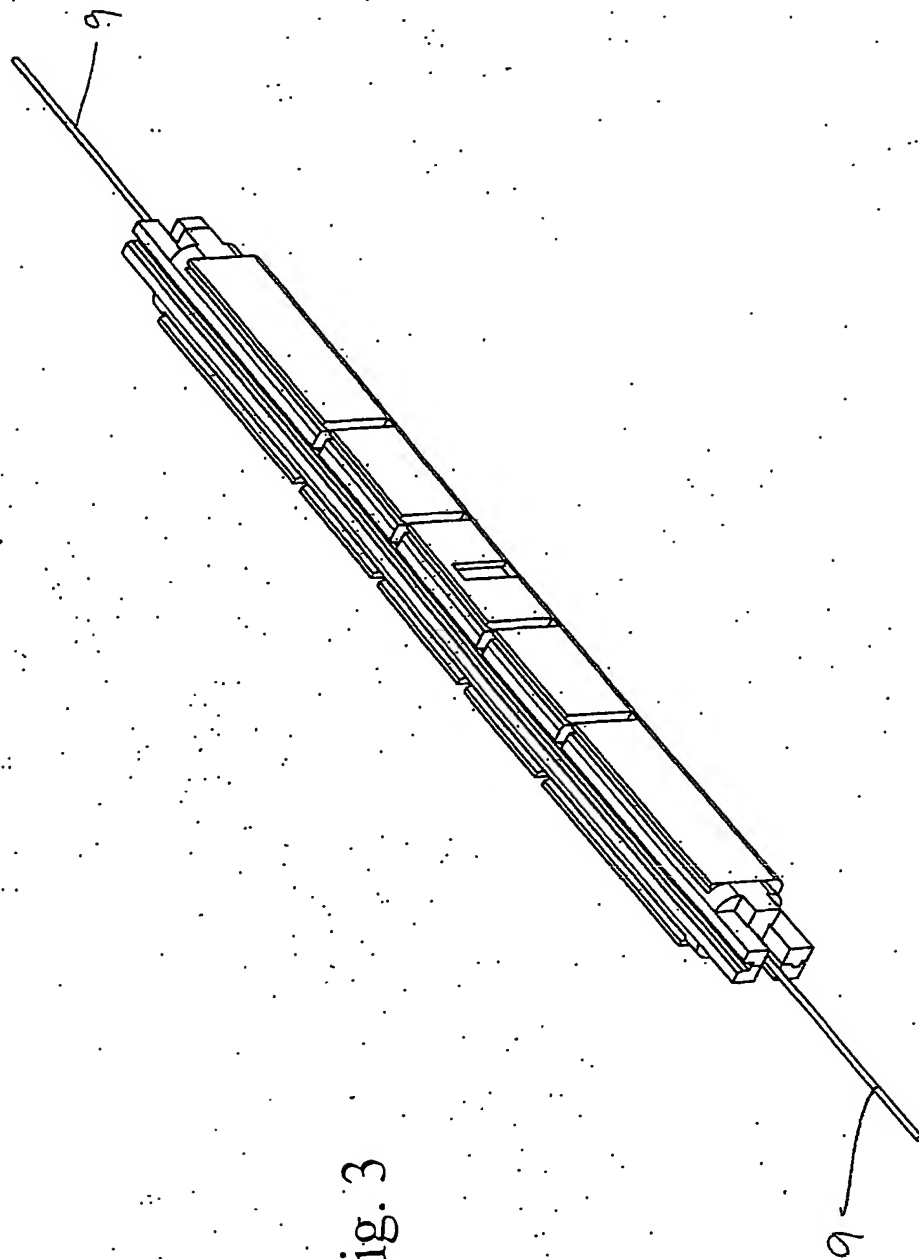


Fig. 3

4/9

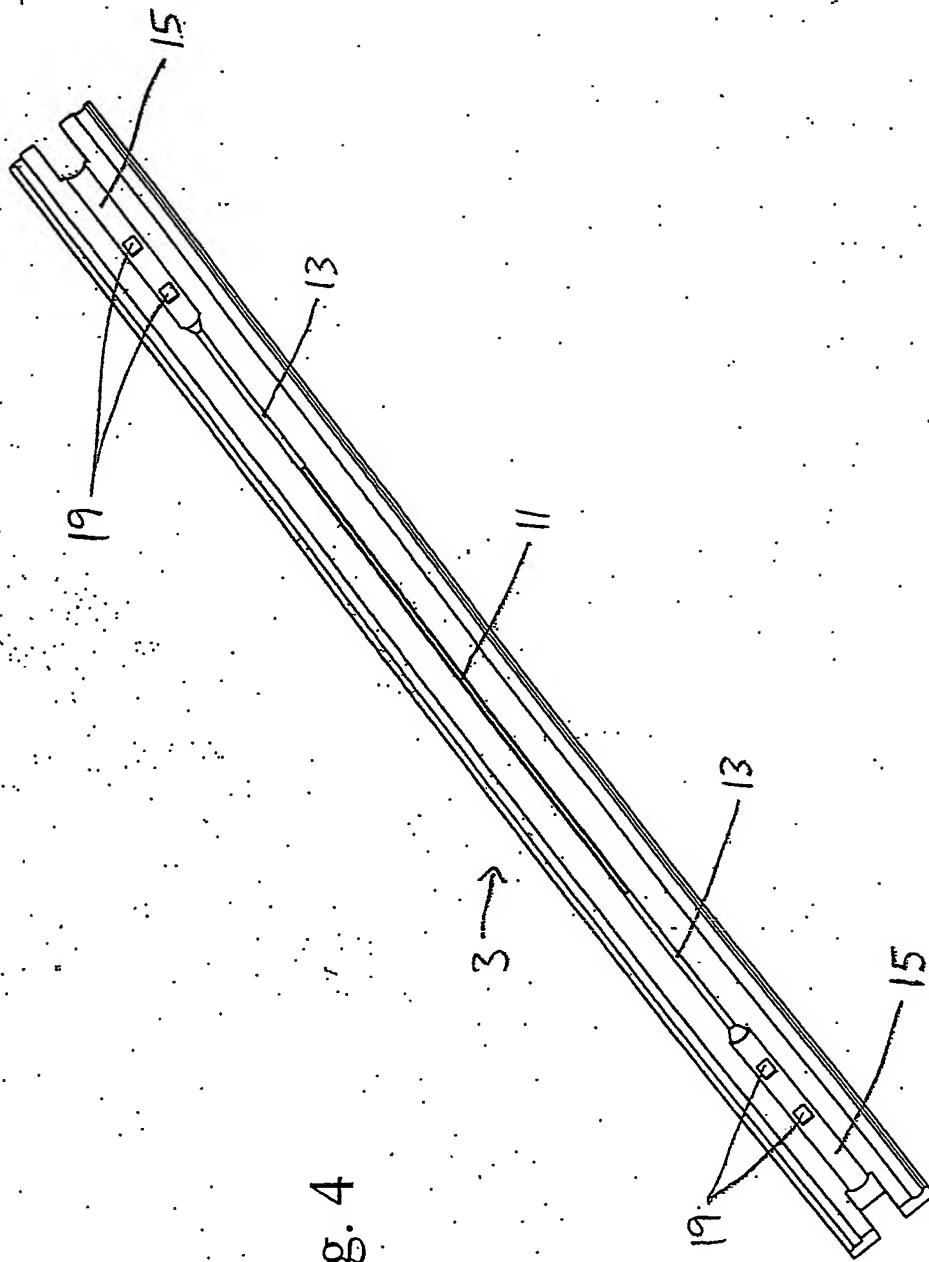


Fig. 4

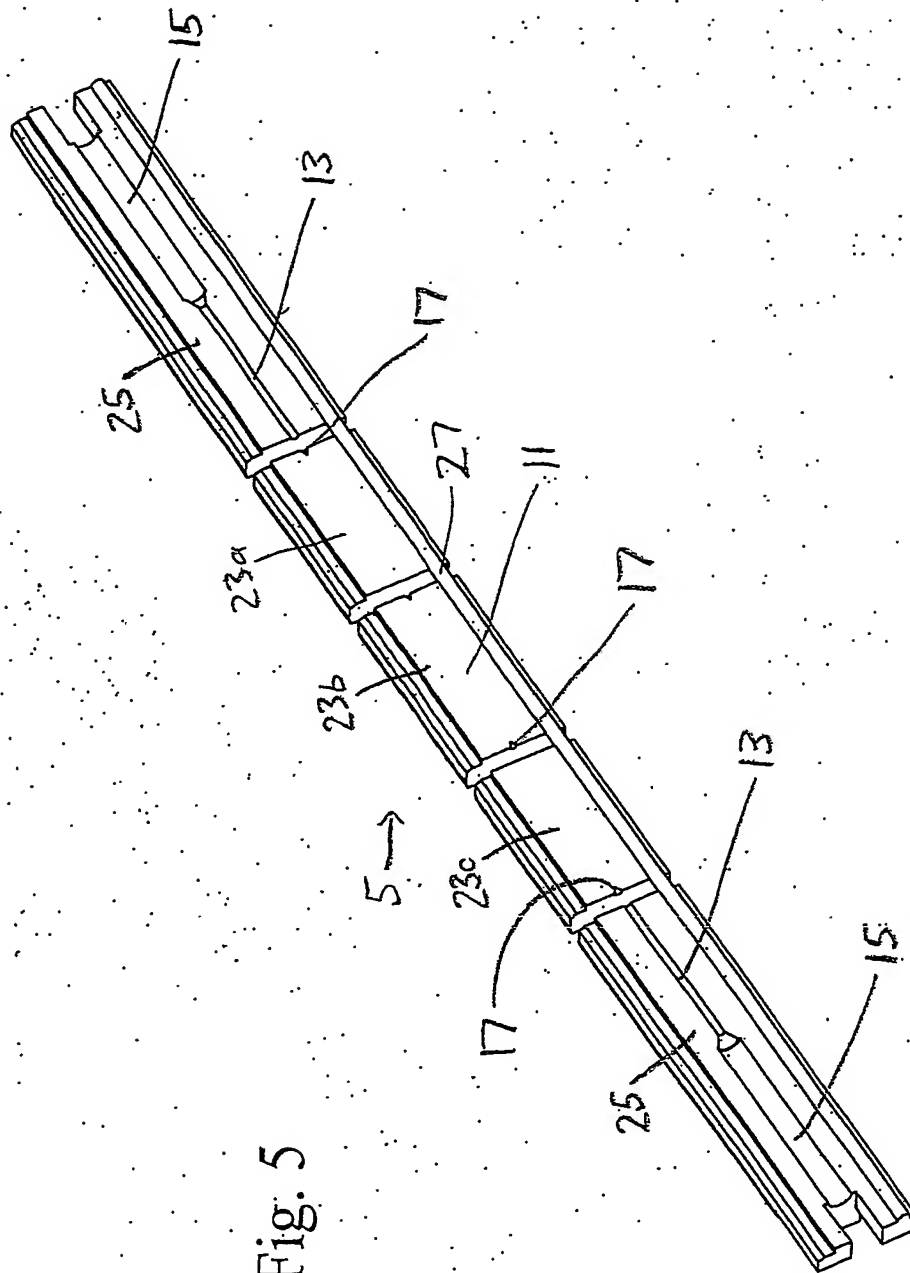


Fig. 5

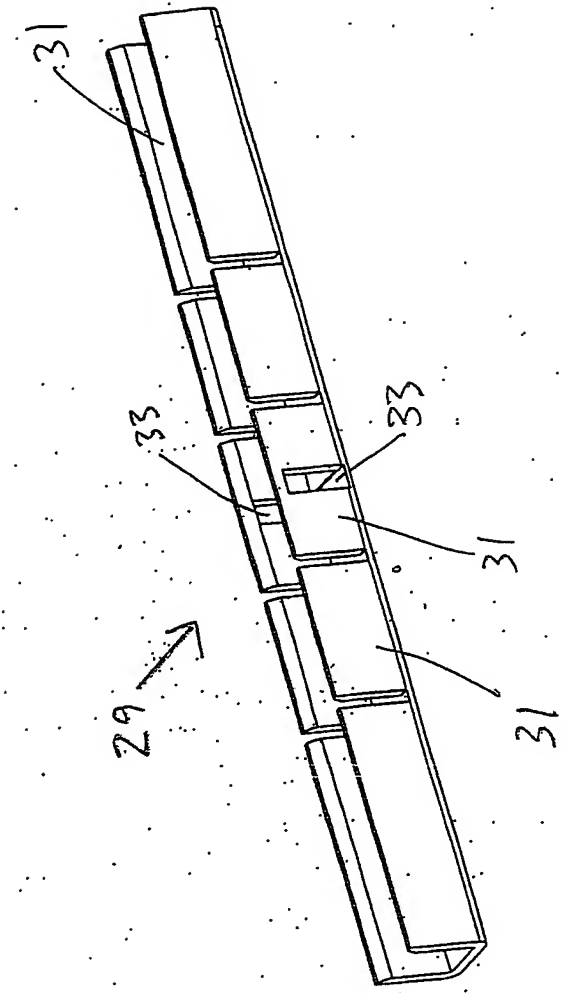
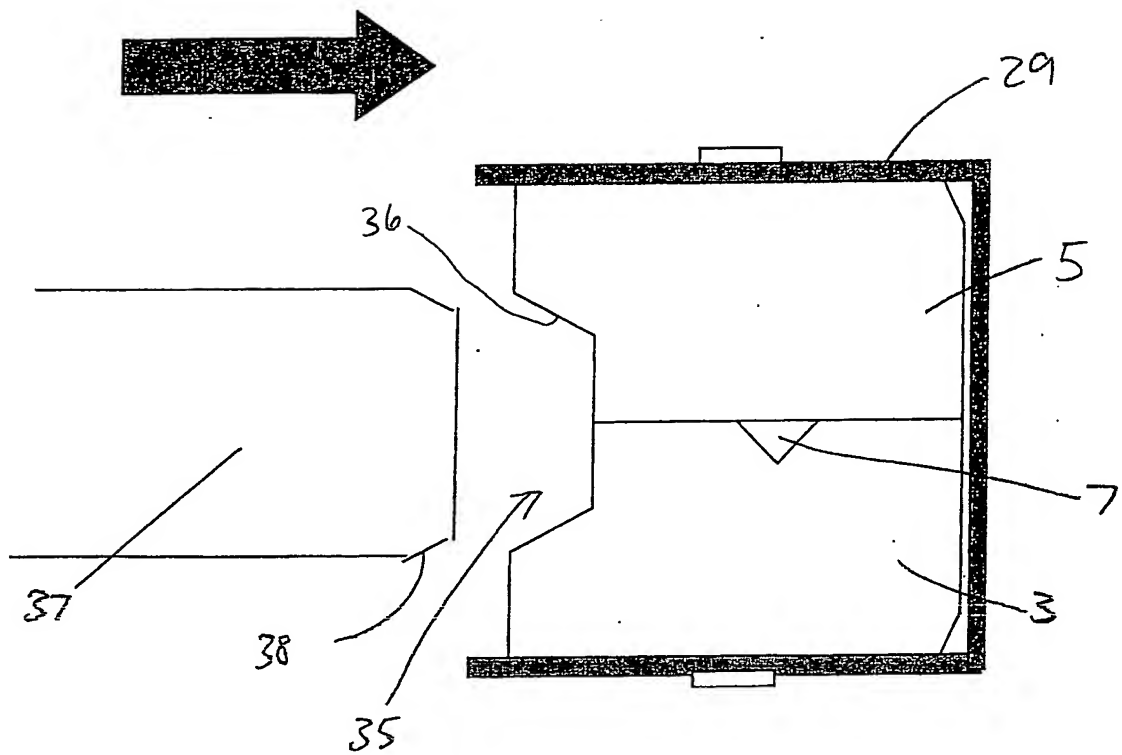


Fig 6

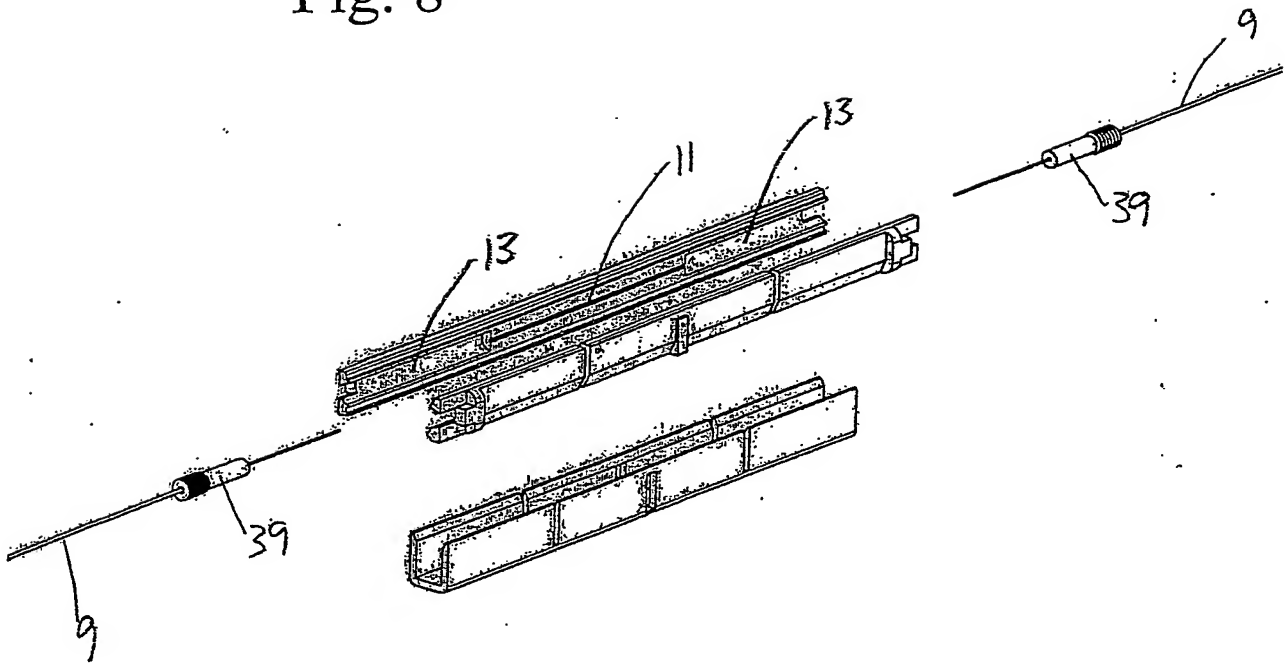
7/9

Fig. 7



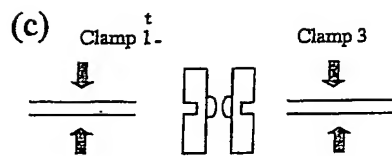
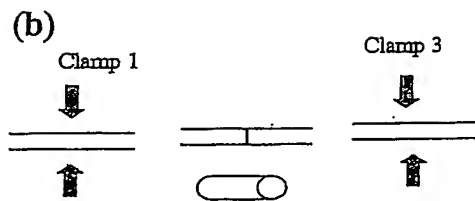
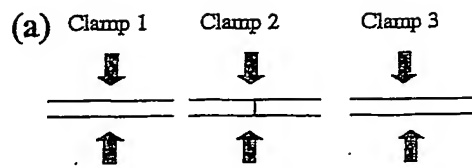
8/9

Fig. 8



9/9

Fig. 9



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record.**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.